change between academic and industrial posts; many men leave chairs to become managers of factories; many men enter the teaching and investigating profession from factories. Chemical and physical factories, too, there form a training school for the younger scientific experts; where many are employed, the more advanced communicate their knowledge and the results of their experience to the junior members of the scientific staff; in fact, they have apprenticeship at its best. Here, in prosperous times, the manufacturer thinks that he has no need of scientific assistance; in times of bad trade he believes that he cannot afford it. And, lastly, the process of training the people has gone on in Germany for nearly a hundred years. Rewards have been given, not to successful examiners, and not in the form of scholarships; but have been earned in the battle of life, for which ample preparation has been given.

This spirit of trust in science has permeated to the highest in the land; that it has been fertile in practical results is amply proved by the inception of the Kaiser-Wilhelm Society for the furtherance of science.

MIMICRY IN THE BUTTERFLIES OF AFRICA.

African Mimetic Butterflies; being Descriptions and Illustrations of the principal known instances of Mimetic Resemblance in the Rhopalocera of the Ethiopian Region, together with an Explanation of the Müllerian and Batesian Theories of Mimicry, and some account of the Evidences on which these Theories are based. By H. Eltringham. Pp. 136+x plates and map. (Oxford: Clarendon Press, 1910.) Price 50*s.* net.

THIS valuable work is in chief part devoted to the "Descriptions of Mimetic Associations in African Rhopalocera," illustrated by nine beautiful coloured plates (ii–x) and by a most useful map of Africa. This—the main object of the book—is preceded by an excellent introductory account of the structure and classification of butterflies, and of mimicry and its relationship to other uses of form, colour, and pattern. The introduction is illustrated by the admirable first plate, showing the characters of the fore-feet of the principal butterfly groups. The discussion of special objections to the theories of mimicry, and a consideration of the evidence by which they are supported, are wisely left to the concluding pages of the text. A useful bibliographical list and an excellent index complete the work.

The extraordinarily rapid growth of knowledge on this subject at the present day is seen in the fact that important new light has been already thrown on certain conclusions in the few months that have elapsed since the appearance of the volume. Thus on p. 31 we read of the family raised by Mr. St. Aubyn Rogers from a female *Hypolimnas misippus* somewhat intermediate between the type and the form *inaria*, and of how the females, without exception, turned out to be *inaria*. But since the day of publication Mr. Rogers has bred in the same locality, Rabai, near Mombasa, another family from an *inaria* female parent, and in this instance all the female offspring were *misippus*! It should be mentioned in connection with this hitherto unpublished result that *misippus* and *inaria* females are about equally common in the locality where the families were reared.

Again, when the book was published it was safe to assert (on p. 96) that the *planemoides* female form of *Papilio dardanus* is restricted to the areas where its *Planema* models are abundant; but Mr. Rogers has now sent an example of it from the neighbourhood of Rabai, and Mr. G. F. Leigh an evidently closely allied very rare form from Durban, the former much to the east, the latter immensely to the south of any locality from which the models have been recorded.

Then the comparatively few African examples of mimicry within the Nymphalinæ have been increased by the recent observations of Mr. W. A. Lamborn that *Diestogyna gambiae*, the female of which resembles the abundant *Catuna angustata*, is constantly to be found in the company of this species.

Our knowledge of mimicry in Africa is progressing at a very rapid rate. To name only the principal naturalists who are directing their attention to this subject at the present moment, we have Mr. A. D. Millar and Mr. G. F. Leigh in Natal, Mr. C. F. M. Swynnerton in south-east Rhodesia, Mr. St. Aubyn Rogers in the Mombasa district, Mr. C. A. Wiggins at Entebbe, and Mr. W. A. Lamborn in the Lagos district. The present writer has found it most inspiring to be associated with all these keen observers and to receive many times in each year the tidings of new discoveries and the material on which they were based.

Mr. Eltringham's work will be of the utmost assistance to these and other naturalists, and it is to be hoped that it will be available in every African centre accessible to students of nature.

It will also be clear from the brief account of the plan and contents of the work that it is certain to be quite as valuable and efficient in stimulating and guiding the beginner as in aiding the expert in the search for fresh discoveries.

A careful and critical study has revealed comparatively few mistakes. All that have been detected are mentioned below, and in a book so full of statements of fact, the list must be regarded as a short one.

In mentioning *Cethosia* (p. 39, n. 2), the Oriental mimic of *Danaida*, it would have been well to point out that we here meet with one of the very rare instances of mimicry in the male, but not in the female. The mimicry is confined to the upper surface, and can hardly be looked upon as "remarkably accurate" in any species of this genus.

The male of *Planema macarista* should have been mentioned on p. 45 as a model of the *aurivillii* form of female of *Acraea alciope*. In both shape of wings and pattern the resemblance to this *Planema* is closer than to *P. poggei*, the model given by the author—a conclusion very clearly expressed in the arrangement of plate viii., but inadvertently omitted from the text.

In discussing, on p. 52, the scanty and somewhat imperfect mimicry of the abundant Danaine, *Tirumala petiverana*, the author omits the important consideration that the species is a *recent* intruder from another area—an intruder still retaining a close resemblance to its nearest Oriental allies.

In speaking, on p. 58, of the "black and white" varieties of *Pseudacraea lucretia* approaching the Danaine model *Amauris echeria*, the author is evidently referring to the individuals in which the normal white markings are to a greater or less extent replaced by ochreous.

It would have been appropriate to place *Acraea esebria* among the mimics of *Planema aganice* and its form *montana* (pp. 73-5). Furthermore, *aganice* is not "confined to the Natal region," but occurs in south-east Rhodesia and probably much farther north along the east coast. *A. esebria*, too, is not only southern (p. 81), but eastern in distribution.

Entebbe is given as the only locality of *Pseudacraea hobleyi* on p. 78, but its female, originally described as *tirikensis*, was first collected by Mr. C. A. Wiggins in a more eastern part of the circumference of the Victoria Nyanza, viz., Tiriki and Nyangori. It has been also received from Toro.

The Pterothysanid moth *Hibrildes neavei* is not "bisexually mimetic, and corresponds to the two sexes of *Acraea anemosa*" (p. 103). The mimetic *Hibrildes* is only known as a female, which probably belongs to one of the previously known non-mimetic males.

The admirable account of the most wonderful mimic in the world, *Papilio dardanus*, is accompanied by plate x, entirely devoted to the forms of this species and the allied *P. meriones* of Madagascar. The part of the preliminary list on p. 92 would have been better, from the point of view of evolution, as well as that of geographical distribution, in the order *polytrophus, dardanus, tibullus, cenea*. A more serious error in the same part of the list is the inclusion of the female forms *dorippoides* and *trimeni* in the sub-species *cenea*, instead of *tibullus*, although both are correctly placed in the full account on p. 100. The male of *dardanus* is inadvertently described as black and white on pp. 93-4, although its "pale yellow ground-colour" is correctly spoken of on p. 97. The males of *tibullus* (East Africa) are characterised by the strong development of the black submarginal band in the hind wing. Those of *cenea* (South Africa) differ in the smaller development of this feature. It increases rapidly as we pass northward, the *cenea* males being transitional into those of *tibullus*. The account on p. 100 conveys a nearly opposite impression.

The classification of so complex a subject as mimicry, under the limitations imposed by the ordinary printed page, must always be a matter of great difficulty. In some respects the author has not grappled with it very successfully. Thus his admirable account of the mimics of *Danaida chrysippus* does not seem to be very happily arranged. The species follow the order of the following column, the members of no single family or sub-family being all together :—

1. *Hypolimnas misippus* : Nymphalinæ.
2. *Pseudacraea poggei* : ,,
5. *Acraea encedon* : Acræinæ.
8. *Mimacraea marshalli* : Lycænidæ.
4. *Argynnis hyperbius* : Nymphalinæ.
7. *Acraea mima* : Acræinæ.
6. *Acraea wigginsi* : ,,
9. *Cooksonia trimeni* : Lycænidæ.
3. *Diestogyna iris* : Nymphalinæ.

In spite of this dislocation of the groups in the text, we find that all four Nymphalinæ are near together on plate ii, while the three Acræinæ and the two Lycænidæ are also together on plate iii. The most obvious sequence on the plates is that indicated by the numbers to the left of the column, a sequence far better than that adopted in the text. It is, in fact, the best possible arrangement, except for the position of *Argynnis hyperbius*, which, being restricted in Africa to Abyssinia, is best placed at the head of the list—as far as possible from all the rest. It would then be followed by the wide-ranging *H. misippus*, the only Nymphaline mimic with which it is associated. The remaining seven species, together with *H. misippus*, form a very natural group, some of them wide-ranging, the others, except the more equatorial *A. wigginsi*, especially characteristic of northern Rhodesia.

Having in view the needs of naturalists who are beginning the study of mimicry in butterflies, and we hope that large numbers of them will seek the valuable and important help offered in this beautiful work, it would have been advantageous to make the group-names a prominent feature in the descriptions of the plates, and also to print comprehensive descriptive titles beneath the plates themselves and above the descriptions of each. Thus plate ii. might have been briefly explained as "*Danaida chrysippus* and its Nymphaline Mimics." The arrangement of models and mimics in separate columns in the description of the plates is an admirable feature, as also is the printing of the names of the species beneath the figures on the plates themselves.

The succession of the models in the text might also, we think, be improved. Thus the deeply interesting series of Planemas with *Pseudacraea* mimics, begun on p. 65, is interrupted (pp. 66-9) by the great black-and-red combination ranged round *Acraea egina*, and by the purely Nymphaline association of *Crenis* and *Crenidomimas* (p. 70), and then again resumed on pp. 70, 71, *et seq.*

The author has wisely preceded his account of mimicry by a classification, on pp. 11, 12, of the chief butterfly groups, with a few of the main features by which each is distinguished. Such a classification will be of great value to those who are beginning the study of mimicry in the field, and have not the means of referring to the literature of the subject. It is a pity, however, that the Brassolinæ and Morphinæ are separated from their close allies, the Satyrinæ, by the intercalation of the Acræinæ and Heliconinæ—these latter being themselves similarly cut off from the Nymphalinæ, to which they bear so close an affinity. The author is here following in the main the key given by Mr. Roland Trimen in his South African Butterflies; but in this great work a linear arrangement based on affinity is printed on the opposite page, and is adopted throughout the volumes.

It is also unfortunate that the division of the "Heliconidæ" of Bates into Ithomiinæ and Heliconinæ is recognised neither in the classification nor in Mr. Eltringham's further discussion of the groups on pp. 17, 18. The composite nature of the "Heliconidæ" was fully accepted and explained by Bates in his paper on mimicry, where he speaks of the "Danaoid" and the "Acræoid" Heliconidæ. And since Bates's time the strong difference on which he insisted has been further emphasised by creating a separate Nymphalid sub-family, the Ithomiinæ or Neotropinæ, for the larger group, the "Danaoid Heliconidæ." *Ituna* and *Thyridia* are mentioned on p. 18 as belonging to the Danainæ; but the latter genus is Ithomiine, as Fritz Müller proved in 1879; and the author's argument in favour of mimetic approach is much strengthened by the great width of the interval between it and *Ituna*. The omissions and errors in this and the last paragraph are, however, concerned with tropical American butterflies, and do not greatly affect the value of a work on African Rhopalocera.

The author's arguments are clear and convincing, and he handles his intricate subject with great skill. The following line of reasoning is, however, open to criticism.

Speaking of the female of the Oriental *Argynnis hyperbius*, which, over nearly the whole area of its distribution, mimics *D. chrysippus*, but in Australia resembles its own male, and is non-mimetic, the author concludes:

> "Since it has become established in Australia before the advent of the Danaine, mimicry of the latter is unnecessary for its continuance."

We are not convinced that this reasoning is sound. It may well be that the representative of *D. chrysippus* has not existed in Australia for a sufficient length of time for the mimicry to have originated; but the above argument seems to imply that a well-established indigenous form would never be influenced by an invading model. There is good evidence that such a change is ultimately wrought, as we see in the effect of the Old World Danaidas upon the North American *Limenitis* (*Basilarchia*), and of the Oriental Tirumalas (*Melinda*) upon the Ethiopian Papilios, so beautifully illustrated by Mr. Eltringham on plate iv of the present work. If these Danaines had not invaded the areas of which we speak, there is little doubt that the species of *Limenitis* and *Papilio* would be still living, but of course without their present mimetic patterns. A certain average proportion of destruction takes place in every generation. The advent of a dominant Danaine model does not necessarily alter this proportion numerically, but affects its quality. Whereas variations in the direction of the model were previously distributed at random among the eliminated and the survivors, they now tend, in each generation, to be more thinly scattered in the former set, more thickly in the latter. And the same conclusion holds for every step by which an elaborate likeness is finally produced.

The above considerations doubtless supply at least in part an interpretation of polymorphism in mimicry —the fact that a single mimicking species often appears in two or more quite different forms resembling different models. For when—by the spread of either itself or the mimic—a new and dominant model, A, comes into relationship with the mimic of an older model, B, the same conclusion holds. The eliminated proportion of the mimic will now for the first time tend to contain less, the surviving proportion more, of any variation in the direction of A, and after a time the mimic may resemble both A and B. Often, but by no means always, such a process is transitional, affording the means by which the mimic finally comes to resemble A in one part of its range, and B in another. A good example is to be found in the female of *Acraea alciope*—a tangled problem most skilfully unravelled by Mr. Eltringham not many months ago. The usual western female of this species mimics the common pattern of the western male Planemas. Further east, at Entebbe, this pattern, although it occurs, is by no means dominant, and the ordinary form of female *alciope* mimics the male of *Planema macarista*, and both sexes of *P. poggei*. But rare examples of the western mimic are still to be found among the *alciope* females at Entebbe, and of the eastern mimic on certain parts of the west coast. The probability that the younger mimetic pattern—almost certainly the eastern—has been reached through dimorphism, is extremely strong.

The author alludes to this deeply interesting subject of polymorphism in mimicry—shown by the recent researches of Dr. Karl Jordan to cover a far wider area than has been hitherto supposed—and infers on pp. 62, 63 that the only interpretation is to be found in Bates's hypothesis of a palatable mimic resembling a distasteful model:

> "We are forced . . . to the conclusion that species which in the same locality produce polymorphic mimetic forms are Batesian mimics, and that the value of the multiple varieties lies in the distribution of the mimetic forms amongst a corresponding number of models, thus avoiding the risk of the edible mimic becoming more numerous than its distasteful model, a state of things which would lead to a disastrous increase in the amount of experimental tasting by insectivorous animals."

In other parts of his work the author himself compels us to doubt the cogency of this reasoning, for he figures and describes such polymorphic mimics among the highly distasteful Acræas—for instance, *A. jodutta*, with its two forms of female at Entebbe, and the wonderful series of mimetic patterns exhibited by *A. johnstoni* in British and German East Africa.

There are a few typographical errors, such as "survivials" on p. 23, which we should scarcely have expected in a book produced by the Oxford University Press, and should also have anticipated that its excellent readers would have directed the attention of the author to an awkward slip in the construction on l. 7 from the bottom of p. 78, as also to a few "split infinitives" scattered through the pages.

The abundant names of species and genera have been very accurately printed. We notice only a single error—*Pseudobazis* for *Pseudohazis*, on p. 118. Among names of persons *Guillème* is printed for *Guillemé*.

Mr. Eltringham's monograph is the first attempt to set forth a nearly full account of mimicry in the butterflies of one of the great tropical regions. He has very wisely selected Africa for his purpose. Its examples are far more numerous and perfect than those of the Oriental region; yet they are manageable and not bewilderingly complicated like those of tropical America. Africa, too, is especially rich in naturalists who are waiting to be inspired and encouraged, as they will assuredly be by the present work. The author is to be congratulated upon the fine volume and the beautiful plates which are the outcome of his labour of love. It cannot be long before he may be congratulated upon their fruitful results. E. B. P.

THE GEOLOGY OF EGYPT.

Geological Map of Egypt. Scale 1 : 1,000,000 (six sheets) and reduction of the same to the scale 1 : 2,000,000. (Cairo: Survey Department, 1910.)

SOON after the occupation of Egypt by a British military force in 1882, the late Prof. Huxley, then president of the Royal Society, directed attention to the valuable opportunity that was afforded for the extension of our geological knowledge in that interesting country. He instanced the valuable series of scientific memoirs that had been prepared by French savants during the occupation of the country at the beginning of the nineteenth century, as an example worthy to be followed. Following his advice, the Royal Society appointed a "Delta Committee" to arrange for explorations, which it seemed desirable to undertake, and made various grants from its funds to defray expenses. The War Department of the Government, on being applied to by the Royal Society, agreed to lend the service of some of the engineer-officers, then in the country, to supervise the work.

As the result of these arrangements, borings were put down at a number of points in the Nile Delta, and reports on the materials sent home were submitted to the society by the Delta Committee in 1885 and 1897, and were published in the Royal Society Proceedings.

But in 1893–4 an engineer-officer, Captain H. G. Lyons, already known in this country by his geological work in the Bagshot area, was employed on patrol work in the oases of Kharga and Dakhla and in the desert routes to the south of them, and he took the opportunity thus afforded to him for making a number of geological observations in the district, which proved to be of great value and interest. Two years later the Egyptian Government decided to establish a geological survey of the country, and to place it under the direction of Captain Lyons. A staff of surveyors was formed, consisting of four young geologists from the Royal College of Science—Messrs. Barron, Beadnell, Hume, and Ball—and for a time Dr. Blankenhorn acted as palæontologist to the survey. The first named of these surveyors, after doing much excellent work, fell a victim to the climate of the Sudan in 1906. A number of very valuable memoirs by Captain Lyons and his staff have been published, some of which have been already reviewed in the pages of NATURE.

As Egypt and the Sudan have no good topographical maps to be placed at the disposal of the geological staff, topographers have had to be attached to each of the geological surveying parties; in this branch of the work Mr. F. W. Green, of Cambridge, a good archæologist, has often served as a volunteer. In 1898 Captain Lyons took over the charge of the whole of the survey departments of Egypt, while continuing his direction of the geological work.

It is not possible here to enumerate all the advances made in our knowledge through the labours of the little staff of geological surveyors in Egypt, but especial mention may be made of the important palæontological discoveries of Mr. Beadnell, aided by Dr. Andrews, in the Fayum, which included the finding of the wonderful Arsinotherium, and the ancestral forms of elephants and whales. Scarcely less interesting and important are the results obtained by Dr. Hume in his surveys of the Sinaitic peninsula, and of the eastern and south-eastern deserts of Egypt; and by Dr. Bell in his work around several of the oases and cataracts.

The results of all these researches are incorporated in the new geological maps of Egypt now issued. In spite of the existence of considerable blanks, these maps are a very great advance on any that have hitherto appeared. The oldest fossiliferous formation recognised is the Carboniferous, but considerable areas have to be mapped as "Nubian sandstones," portions of which may be of different geological age; there are also beds of gypsum, the position of which in the geological series is in some cases still doubtful. The Cretaceous strata are divided into Cenomanian, Senonian, and Danian, while the extensively developed Eocene strata have been distributed in three local divisions. Strata referred to the Miocene and Pliocene also occur, while Pleistocene and more recent deposits obscure wide areas. The larger-scale map forms six sheets, and the smaller a single sheet; all these are admirably printed in colour, and corresponding maps with hill-shading have also been issued by the Survey Department.

The survey staff has lost its original director, Captain Lyons, and also Mr. Beadnell, but it has been reinforced by the appointment of Mr. H. T. Ferrar, the geologist of Captain Scott's first Antarctic expedition; there have also been several other geologists who have served temporarily on the staff. The work is carried on at the present time under the directorship of Dr. W. Fraser Hume, who has had such a wide experience in desert-work, and is responsible for the maps which form the subject of the present notice. We are glad to learn from the last issued report of the survey that Dr. Hume proposes to write a general sketch of the "Geology of Egypt," this work, from such capable hands, will be looked forward to by geologists with much interest.

J. W. J.

THE BEGINNINGS OF BOTANY.

Landmarks of Botanical History. A Study in Certain Epochs in the Development of the Science of Botany. Part i., Prior to 1562 A.D. By E. L. Greene. Pp. 329. (City of Washington: Smithsonian Institution, 1909; Smithsonian Miscellaneous Collection, part of vol. xliv.)

DR. GREENE has contributed to the history of the progress of botany a work that bears evidence of unwearied research into the labours of